Northern Science for Northern Society

Building Economic Self-Reliance

Science Council of Canada Report 41

Science Council of Canada
Conseil des sciences du Canada

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April 1991

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Other Science Council publications relating to the North include *Harnessing Science and Technology for Cold Regions*, a statement released in 1989 and *Northward Looking: A Strategy and a Science Policy for Northern Development*, a report issued in 1977.

Cover: A commercial char fishery in N.W.T. demonstrates the potential of scence and technology in the economic development of a northern community. *Photo courtesy of Mike Beedell.*

91-06055/

April 1991

The Honourable William C. Winegard, PC, MP
Minister for Science
House of Commons
Ottawa, Ontario

Dear Dr Winegard:

In accordance with Section 13 of the Science Council of Canada Act, I take pleasure in forwarding to you the Council's Report No. 41, *Northern Science for Northern Society: Building Economic Self-Reliance*.

Yours sincerely,

Janet E. Halliwell
Chairman
Science Council of Canada

Contents

Foreword	7
Summary	9
1. The Environment for Decision-Making	11
2. The Challenge to Development	23
3. Directions for the Future	33
4. Getting Started	41
Notes	42
Committee on S&T for Northern Community Economic Development	43
Science Council of Canada	44

Foreword

Attempts to develop the North have, until now, generally been initiated in southern Canada in response to southern needs and priorities. Not surprisingly, southern Canada seems to have reaped a disproportionate share of the benefits. Today, northerners are seeking to reverse this trend by demanding a greater say in the pace and direction of their own development. The Science Council supports such claims as the most direct and sensible route to improving economic conditions in the North.

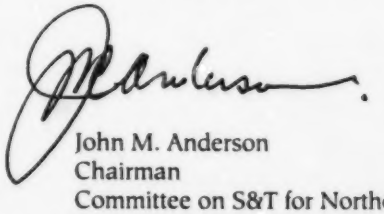
In 1988 the Science Council launched a study to look into the institutional changes needed to help northerners apply science and technology to the economic development of their communities. The study commenced with extensive consultations in northern and southern Canada with representatives of aboriginal groups, governments, the private and education sectors, and science and technology advisory bodies. The goal was to elicit opinions on the problems facing northern communities in their application of science and technology to development and to identify solutions. Consultations continued into early 1990 and culminated in a national conference in Yellowknife in March that year.

As part of the study, the Science Council also commissioned case studies in six northern communities to explore northerners' experiences with science and technology-based development.* The studies were carried out in Kuujjuaq, Quebec; Inuvik, Northwest Territories; Haines Junction, Yukon; Nain, Labrador; Waskaganish, Quebec; and St. Paul Island, Alaska. Conducted in the first half of 1990, these case studies provided ideas about specific opportunities or problems in the application of science and technology. (The Alaska case study was jointly funded by the Science Council and the Alaska Science and Engineering Advisory Commission.)

The findings from the consultations, conference, and case studies were then used to put together a discussion paper, *S&T in Northern Community Economic Development: Overview of Current Needs and Potential Future Directions*. This was sent to relevant persons in northern and southern Canada for comment on the recommendations and subsequently used as a basis for drafting this report.

The Science Council believes the recommendations in *Northern Science for Northern Society: Building Economic Self-Reliance* are both timely and appropriate. Their release coincides with the beginning of a new political era in the North, in which devolution of power and the settlement of land claims are giving northerners a greater opportunity to determine their own destinies. More importantly, northerners have been key players in developing and reviewing the recommendations, which, therefore, respond closely to their needs, concerns, and appreciation of what is feasible.

In conducting this study, the Science Council has played the role of facilitator and catalyst. The consultations, conference, and drafts of the report generated interest from northern communities across Canada. The published recommendations, with the political will to implement them, will give these communities the control they need to put science and technology to work for them.



John M. Anderson
Chairman
Committee on S&T for Northern
Community Economic Development
Science Council of Canada

* The case studies will be available in manuscript form in the summer of 1991.

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Summary

Canada's northerners have long been among this country's economic have-nots. Not all northern communities look poor — thanks to government spending on infrastructure such as roads, schools, and housing — but jobs are few, incomes and educational levels low, and dependence on government handouts high. As a new baby-boom generation approaches adulthood with little prospect of employment, conditions will likely worsen.

What can be done to reverse the economic fortunes of the North and put it on the road to greater economic self-reliance? The Science Council of Canada and a growing number of northerners believe that much of the answer lies in integrating science and technology into the economic development of northern communities. And northerners themselves must both initiate and control the process of integration.

In this report, the Council pinpoints four areas where institutional change is needed:

- science education and technical training;
- the collection and dissemination of scientific and technological information;
- support for technology development, adaptation, and transfer;
- circumpolar cooperation.

The Science Council supports the long-term goal that science education and technical training programs be located in the North and designed and delivered by northerners. For the immediate future, the Council calls for northerners to assume increasing control over the design and delivery of local programs. The Council also encourages northern school boards and colleges to base their courses and programs on the northern environment and local cultures.

To help northerners obtain scientific and technological information that is relevant and comprehensible to them, the Council recommends strengthening those organizations operating in the North that can play a liaison role between existing information systems and northern residents. To further improve the scientific and technological information base for northerners, the Council proposes (a) establishing more local organizations to carry out scientific research in northern regions and (b) encouraging more southern scientists to conduct research that is geared to northerners' needs. The incorporation of indigenous knowledge in northern information systems would also do much to improve the knowledge base for northerners, as would enhanced avenues for east-west information exchange.

Government programs are needed to reinforce northerners' efforts at technology development, adaptation, and transfer. The Council urges that, until northerners and their community economic development organizations have the expertise and resources to design and deliver appropriate support programs on their own, such functions should be a joint responsibility of community economic development organizations and relevant government departments. Government support must also be more strongly oriented to technology-based initiatives. Another area where joint responsibility is called for is in the design and delivery of business management training programs.

Finally, Canada's northerners would benefit from first-hand contact with other northern peoples to exchange ideas and experiences relating to technology-based development. Thus the Council proposes the establishment of circumpolar organizations whose purpose is to facilitate regular meetings of northern peoples.

There is no one ideal way to implement the report's recommendations. But as a first step northern communities should consider holding meetings or workshops to develop the vision and commitment needed to capitalize on strengths and overcome weaknesses. Community cooperation and self-help are the basis of a brighter economic future for the North.

Canada's North

There are many ways of defining Canada's North. Some highly restrictive definitions limit it to the extreme northern part of the Northwest Territories, which is nearly uninhabited; other definitions include the Yukon and Northwest Territories, while still others include the Yukon and Northwest Territories as well as Labrador and the part of northern Quebec bordering on Hudson and Ungava bays.

In conducting this study the Science Council understood the North generally to be that part of Canada lying north of the southern limit of the discontinuous permafrost zone. It includes the Yukon, Northwest Territories, and northern parts of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Labrador. Communities north of the line of discontinuous permafrost are characterized by remoteness, long, cold, dark winters, a large proportion of aboriginal peoples, sparse population, and high dependence on external sources of revenue. However, areas where "northern" conditions apply can also be found south of the permafrost line; for purposes of this report, such areas should also be considered part of the North.

Canada's North: Selected Communities

Source: Statistics Canada, Census of Canada 1986

1. The Environment for Decision-Making

In 1970, decisions about policy, priorities, and spending in the North reflected, to a large extent, national objectives. Today, a burgeoning youth population, environmental concerns, the political and administrative evolution of the Yukon and Northwest Territories, and the settlement of northern aboriginal land claims increasingly determine what decisions are made. Yet, in some ways the environment for decision-making remains the same. Remarkably unchanged, for example, is the North's dependence on capital from external sources as the basis for economic development and the creation of social infrastructure.

The Socioeconomic Backdrop

There are hundreds of communities scattered throughout Canada's North. Whitehorse and Yellowknife are modern capitals, with the technological sophistication, skilled labour, managerial and entrepreneurial talent, and amenities of life of southern Canadian towns their size. Their residents enjoy average incomes comparable to the average for all Canadians.[1] Most communities, however, have a population of fewer than 1500 persons. These communities often look modern enough, by virtue of the substantial public investment in infrastructure that has been made over the last 20 years. But they are places without much of what most Canadians think of as modern economic life. Education levels are low and jobs are few. The people, a large percentage of whom are aboriginal, live by a mix of whatever economic opportunities are available — income in cash derived from wages, commodity production (furs, fish, art, handicrafts) and transfer payments, and also non-market income from the subsistence economy of hunting, fishing, and trapping. Their average cash incomes are substantially lower than those of residents in the larger northern centres, where populations are largely non-aboriginal, or in the South.[2] Much of the economic activity in the smaller communities, however, goes unmeasured and unrecorded, and hence overlooked by conventional economic statistics. In fact, non-market income from subsistence harvesting is a highly important source of income (chart 5). It is one of the few sectors of the economy in which these communities even begin to approach self-sufficiency.[3] As a result, actual average incomes may be higher than commonly portrayed by conventional economic analysis.

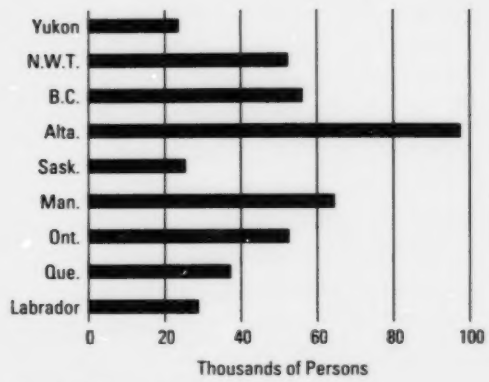
All these communities, even the larger northern centres, are highly dependent on the infusion of capital from external sources. Because of high costs and low cash incomes, and the near absence of a taxable property base, many of the facilities in northern communities are paid for by federal — and, to a much lesser extent, provincial and territorial — government expenditures, and, ultimately, by the Canadian taxpayer. Housing, schools, nursing stations, sewer systems, roads and airstrips, electrical power generation, fish plants, and a variety of other services are all fully or heavily subsidized.

Small northern communities lack many of the amenities of modern economic life.

Industry, Science and Technology Canada Photo

The availability and quality of such facilities are not always adequate. Housing is overcrowded, and much of the housing stock is obsolescent. Hospitals and doctors are typically hundreds of miles away. Because of high transportation costs, government budgets can buy only a fraction of what they could in the South. Budgets, strained from pouring billions of dollars into upgrading the inadequate physical infrastructure over the years, were left with relatively little to direct at community economic development.[4] To date, northern communities have avoided the full brunt of federal restraint. Now, restraint on further growth in federal revenue transfers to the territories is likely unavoidable.[5]

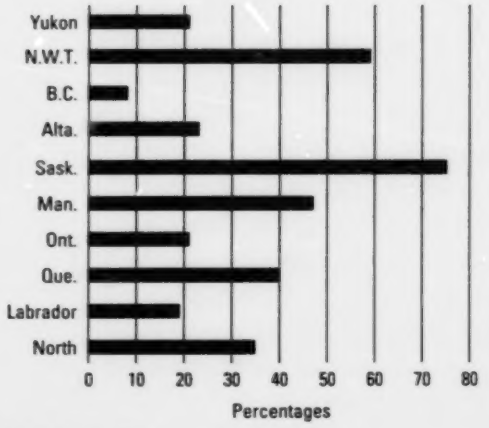
1. Northern Populations, 1986



Total northern population: 437 000

Source: Statistics Canada, Census of Canada 1986.
(Available data do not always conform with this report's understanding of the North, p. 10.)

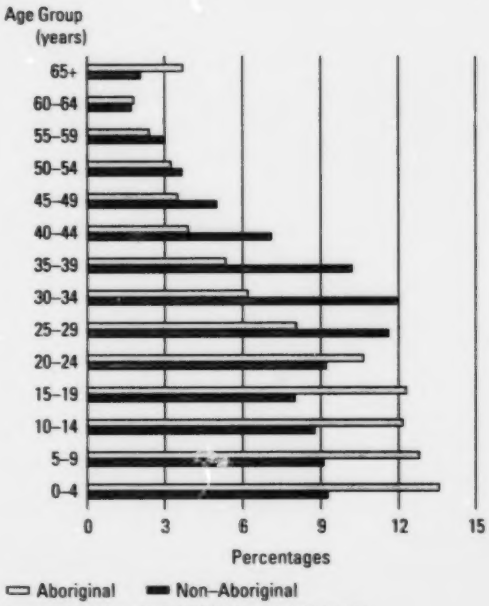
2. Aboriginal People as a Proportion of Northern Populations, 1986



National average = 3%

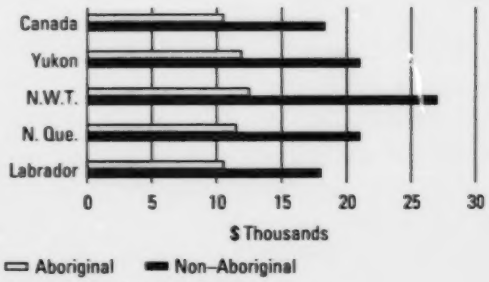
Source: Statistics Canada, Census of Canada 1986.
(Available data do not always conform with this report's understanding of the North, p. 10.)

3. Population by Age Distribution, 1986, Yukon, N.W.T., Northern Quebec, Labrador



Source: Adapted from data in A. M. Maslove and D. C. Hawkes, *Canada's North, A Profile* (Ottawa: Statistics Canada, 1990), 19.

4. Average Income, Canada, Yukon, N.W.T., Northern Quebec, Labrador, 1985

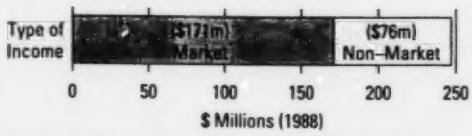


Source: A. M. Maslove and D. C. Hawkes, *Canada's North, A Profile* (Ottawa: Statistics Canada, 1990), 30.

Northern communities are also feeling demographic pressures. Over 50 per cent of the aboriginal population is under 25. Emigration rates are low, and there is no evidence that significant numbers of residents wish to, or could be induced to, leave for major northern centres or the South. The young people who will enter the northern labour market in the next decade will create a requirement for thousands of new jobs. During the past two decades, mining and oil and gas have been particularly important sources of cash income and employment in northern communities. However, these resource sectors are currently in a relative decline, and northerners face a shrunken labour market.[6] The loss of cash incomes from wages, moreover, threatens the aboriginals' pursuit of fishing and hunting for food, since this demands significant infusions of cash to meet capital and operating costs.

Given the situation, it is hardly surprising that trying to find solutions to northern economic problems has become an increasing preoccupation of governments and north-

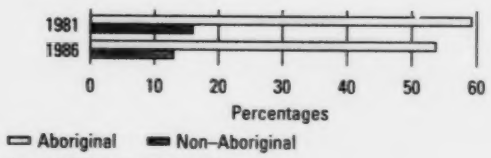
5. Market Income and Non–Market (from Subsistence Harvesting) Income for Aboriginal People in N.W.T., circa 1980



Source: Adapted from data in E. Weick, *The Native Economy of the Northwest Territories – Policy Perspectives and Data Needs*, Unpublished paper, 1990, 11a; and P. Usher and G. Wenzel, "Socio-Economic Aspects of Harvesting," in *Keeping on the Land: A Study of the Feasibility of a Comprehensive Wildlife Harvest Support Programme on the Northwest Territories* (Ottawa: Canadian Arctic Resources Committee, 1988), 47-48.

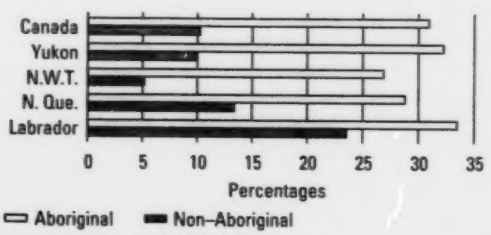
Note: The estimated value of non-market income shown in this chart is higher than some other estimated values. The figure of $76 million includes added-back assumed production costs and adjustments for undercounting and undervaluation of the harvests.

6. Population 15 Years and Over with No Secondary Schooling, Yukon, N.W.T., Northern Quebec, Labrador



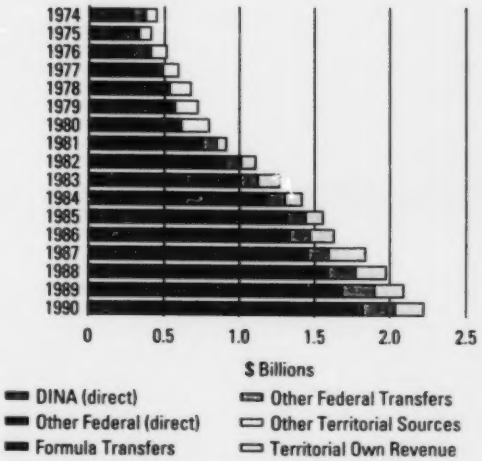
Source: A.M. Maslove and D.C. Hawkes, *Canada's North, A Profile* (Ottawa: Statistics Canada, 1990), 26.

7. Unemployment Rate, Canada, Yukon, N.W.T., Northern Quebec, Labrador, 1986



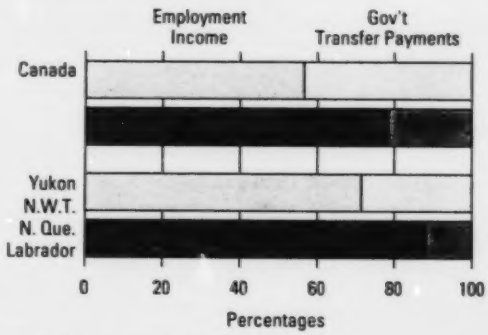
Source: A. M. Maslove and D. C. Hawkes, *Canada's North, A Profile* (Ottawa: Statistics Canada, 1990), 28.

8. Government Expenditures on the Yukon and N.W.T., 1974 to 1990



Source: Combined data from Department of Indian and Northern Affairs, Constitutional Development and Strategic Planning Branch, *A Northern Political and Economic Framework* (Ottawa: Supply and Services Canada, 1988), 13; and *Northern Indicators*, 1990, unpublished.

9. Population 15 Years and Over by Major Source of Income, 1985, Canada, Yukon, N.W.T., Northern Quebec, Labrador



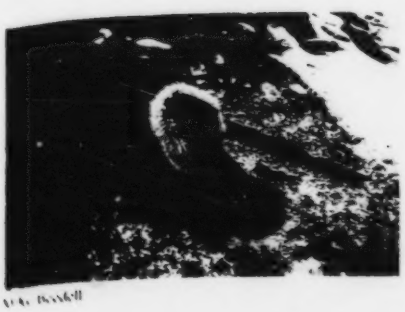
Source: A. M. Maslove and D. C. Hawkes, *Canada's North, A Profile* (Ottawa: Statistics Canada, 1990), 30.

erners. Throughout the North greater economic self-reliance is of prime concern, and it is stated government policy in the Northwest Territories and Yukon to move in that direction.[7] The federal government's northern strategy includes as one of its primary objectives support for community economic development.[8] Although opinion is divided about the best course forward, there is a growing consensus at all levels that a new economic development strategy is needed, one that will ensure the viability of the community-based economy and stabilize the "boom and bust" cycles that have characterized the northern economy in the past. The development of export commodities remains important, but self-reliance through economic diversification is receiving a much higher priority than in the past.

The potential for economic diversification in northern communities is closely tied to the use of the North's diverse natural resources. Thus, northerners are attaching increasing importance to ownership and control of the North's land and resources.

Land Claims Settlements

A number of northern aboriginal land claims have been settled in the past 20 years. In 1975, the James Bay and Northern Quebec Agreement gave the Inuit and Cree of Northern Quebec $225 million and land rights over an extensive area. In 1984, the Committee for Original Peoples' Entitlement reached a settlement with the federal government that gave the Inuit in the Beaufort Sea area $161.6 million and extensive land rights. Other land claims, such as those of the Council for Yukon Indians, the Déné/Métis in the Mackenzie Valley, the Inuit located in the central and eastern Arctic, and the Inuit in northern Labrador, are at different stages of negotiation, but settlements, at least for the land claims of the Northwest Territories and Yukon aboriginals, could well be reached in the near future.



Subsistence harvesting is an important source of income for many northern communities.

The impetus to settle northern aboriginal land claims stems in part from the larger society's desire to develop important energy resources contained in traditional aboriginal lands and the need somehow to ensure that aboriginal people fit willingly into the development process. This was the situation in the James Bay lowlands of Quebec and along the Beaufort coast. The increasing likelihood of imminent settlements in the two territories also reflects the federal government's comprehensive land claims policy of 1986, whose purpose is to provide certainty and clarity of rights to ownership and use of land and resources in those areas of Canada where aboriginal title has not been dealt with by treaty or superseded by law.[9] Settlements are important in creating a climate of greater certainty for business and industry in development of resources.

Settlement of land claims is less complicated in the two territories than it is in the provinces, where most of the land and resources fall under provincial jurisdiction. Although there are sometimes serious conflicts of interest and of strategy between aboriginal organizations and the territorial governments, the Yukon and Northwest Territories have for a number of years formally supported aboriginal people in claims negotiations. Settlements in the territories are important in paving the way for transfer of provincial-type responsibilities as well as in creating a climate of certainty for business and industry. On the other hand, some of the provinces have refused to recognize the legitimacy of aboriginal land claims. This situation is rapidly changing, however, owing to the increasing impatience of aboriginals across Canada over the delays.

To date, settled northern land claims have been closely tied to major non-renewable resource projects. Aboriginal people in the James Bay lowlands of Quebec and along the Beaufort coast were given a stake in such development, and became dependent on it even when it was fundamentally in conflict with their way of life. Thus the Inuvialuit along the Beaufort coast are now in the position of waiting for the oil rigs to come back. Given the relative decline of the resource industries in the North, it is hardly surprising that claims-negotiating bodies are placing increasing emphasis on obtaining control over the lands and resources upon which the subsistence economy depends. The settlement of outstanding northern land claims will provide aboriginals with a voice in the management of the North's natural resources and, moreover, with the land and resources necessary to participate in new economic ventures.

Political and Administrative Evolution of the Territories

The political structure of the Yukon and the Northwest Territories has evolved substantially in the last 20 years. Increasing political and fiscal autonomy in the two territories is reflected in the diminished role of the federally appointed commissioner and in greater territorial discretionary spending authority.

Nonetheless, the two territories are not standing on the verge of provincial status today. They still lack authority over certain matters that the provinces govern. Notably,

the federal government continues to maintain ownership and exercise sovereign jurisdiction over most of the two territories' land and resources, both renewable and non-renewable. Given their dependence on natural resources, the territories have only limited ability to achieve greater economic self-reliance and a better life for their residents. Discretionary spending authority to meet northern priorities is still hampered by the lack of ownership of revenue-producing resources.

The Mulroney government is pursuing the political and administrative evolution of the two territories more actively than its predecessors. The most recent federal policy on the political evolution of the two territories is directed at encouraging the development of effective political institutions primarily through transferring responsibility for managing the territories' natural resources to the territorial governments.[10] For example, in 1988, an agreement-in-principle on a federal-territorial northern accord for oil and gas activities was signed, and resource revenue sharing formulae are currently being discussed. Similarly, the governments of Canada and the Yukon are negotiating transfers of responsibility for the freshwater fishery, forest management, water management, and lands management. No doubt part of the impetus for devolution of resource and program control comes from the federal government's desire to divest itself of responsibilities that in recent history have carried a rapidly escalating price tag. Nevertheless, the territories do not have a constitutional base for these powers.

In the Yukon, the devolution of federal northern programs and budgets to the territorial administration is, for the most part, supported by the territorial government and the residents.[11] In the Northwest Territories, devolution is a policy favoured more in the west than in the east, and more by the white population than by the aboriginal people. It is especially favoured by territorial political leaders.[12] In the east, the Inuit, who make up 80 per cent of the population, have a long-standing commitment to defining a new territory, Nunavut, in the Inuit portions of the Northwest Territories. The philosophy behind Nunavut is that northern aboriginal histories and cultures must be determining factors in the shape of new governmental arrangements and institutions. The Inuit see devolution as consolidating an unsatisfactory political system and making the creation of a Nunavut government less likely.[13]

Division of the Northwest Territories into an eastern and western territory has been supported by both Liberal and Conservative governments in Ottawa in the past decade. The federal government's position in 1985 was that division was contingent on a territorial consensus on a boundary, the location of administrative centres, and the division of powers between local, regional, and territorial levels of government. In 1987, the Constitutional Alliance of the Northwest Territories reached consensus on the Boundary and Constitutional Agreement for the Implementation of Division of the Northwest Territories. The legislative assembly subsequently approved the agreement and decided to proceed with a plebiscite on the proposed boundary. The initiative has not yet recovered from an eleventh-hour failure in 1987; nevertheless, the strong commitment of the Inuit to the concept of Nunavut will ensure that the question of division of the Northwest Territories will persist. Meanwhile, the territorial government continues to advance itself as the only legitimate political force. The current federal policy of transferring northern programs and budgets to the territorial administrations appears to support this view.

There will undoubtedly be further discussions and negotiations on constitutional status within both territories. Until many of the problems still at issue are settled, factionalism will continue, and the territories' commitment to greater economic self-reliance will be difficult to achieve. Delay in settling the political and administrative evolution of the territories may well result in a continuation of the economic status quo. Although the Meech Lake Accord was bitterly attacked for its treatment of the two territories, the media attention surrounding the Accord may have produced some benefits. If nothing else it has highlighted their ambiguous constitutional status.[14]

Growing Environmental Awareness

Although the North possesses extensive and rare mineral deposits and sizeable oil and gas reserves, once removed they cannot be

Integrating Traditional Aboriginal Knowledge and Modern Technology

One of the functions of the Igloolik Research Centre, an agency of the Science Institute of the Northwest Territories, is to find ways of transferring technology to benefit Inuit hunters, trappers, and fishermen. In one recent project an informal committee of Inuit hunters examined the potential for using fibreglass to construct floe-edge boats. The goal was to produce a safer boat by integrating traditional Inuit knowledge of boat design and conditions of floe-edge hunting with new technology.

The floe-edge boat is widely used by Inuit hunters of the eastern Arctic to retrieve seals shot in the sea at the floe edge. It is also used for setting fishing nets in summer, protecting possessions on a sled when travelling by snowmobile on wet spring ice, and storing hunting and camping equipment.

Floe-edge boats were developed at the beginning of the 20th century when kayaks fell into general disuse. They were originally made of sealskin sewn over a frame made from driftwood or wood obtained from traders or missionaries. Since the 1960s, more wood has been shipped to the North and boats have generally been made from pieces of plywood nailed over a wooden frame and sealed by letting water freeze over the joints. The boats are usually 10 to 12 feet long, with a 3-foot beam. A peculiar design feature is the extremely low sides, which make the boats easy to swamp but reduce the surface that is exposed to the wind. The reason is that for hunters operating at the floe edge, being blown out to sea is a greater hazard than sinking.

As the project evolved several changes were made to the traditional design of the boat, and a tough, but lightweight, fibreglass cloth was chosen for the hull — weight was an important consideration because of the high cost of shipping materials to the North. The final design called for two layers of fibreglass sandwiching a core of polyurethane sheeting, which gives the boat greater structural strength and flotation. Additional flotation material was placed in the bow and stern.

The use of fibreglass allowed the incorporation of a smooth rocker, which made the boat easier to manoeuvre than a wooden boat. Two runners added at the bottom of the sides gave the boat greater directional stability in the water and allowed it to glide easily on ice. The runners, the smooth rocker, and a coating of gel made it easier to run a returning boat right out of the water onto ice. Recessed handholds allowed a firm grip with icy mitts.

Hunters who tested the prototypes were delighted with the results. They found the boats more stable than wooden ones because of their greater weight. The extra flotation meant they could support one person even when fully swamped.

In fall 1988, funding from the Northwest Territories Department of Renewable Resources permitted the centre to build nine boats. The boats sold quickly and interested people began calling from all over the eastern Canadian Arctic. More interest was created when a boat was shown at the Globe '90 conference in Vancouver in March 1990.

Thanks to the project, at least five people in the Inuit community are expert in producing the fibreglass boats and can instruct others in building their own. The materials and an instructor are available for only $500, placing the boat within the reach of any hunter who wants one.

By bringing together traditional Inuit knowledge and new technology, the project has made a safer and more manoeuvrable boat available to Inuit hunters. And by involving Inuit hunters directly in the planning and production, the project has also demonstrated how Inuit can integrate new materials and new production technologies into their culture and adapt them to their needs.

renewed. The development of renewable resources such as wildlife, fish, and trees is constrained by the low biological productivity of northern ecosystems and pollution generated both within and outside the North. For example, pollution from eastern North America and Europe is contaminating the meat of Arctic wildlife. This contamination is passed along to humans who eat the meat — a problem highlighted recently by the discovery of alarmingly high levels of PCBs in the milk of Inuit mothers in northern Quebec. More difficult to assess are the threats posed by the hole in the ozone layer over the Arctic, the Arctic haze phenomenon, and global warming. Another problem is the increasing population of the North, and the ensuing demands on the wildlife, as well as on sources of energy, water supplies, and materials for housing. The increased production of wastes, in turn, will further stress vulnerable ecosystems.

Although the Canadian government has had the primary responsibility for protecting most of the Arctic environment north of 60 degrees (south of 60 degrees the provinces own and control most public lands and resources), devolution and northern land claims settlements are changing the situation. The territorial governments and joint management boards, band councils, and aboriginal institutions established under the constitutionally entrenched land claims agreements will exercise considerable authority over wildlife, fisheries, land and water management, and resource development projects. For instance, under the Inuvialuit Final Agreement and the Déné-Métis and Tungavik Federation of Nunavut agreements-in-principle, joint boards for wildlife, fisheries, land and water management, land-use planning, and environmental impact assessment and review have been or will be created. The relevant aboriginal organization is generally entitled to appoint half the members of these boards; federal and territorial governments appoint the other half.

Northerners increasingly view conservation and economic development as potentially complementary goals, provided they have the tools to control the pace and character of development. Thus, claims-negotiating bodies have emphasized control over, and a much more active use of, resource and environmental tools for both conservation and economic ends. Moreover, work is under way in northern Canada and throughout the circumpolar region on several initiatives related to conservation and sustainable development. Included are such initiatives as the Arctic Marine Conservation Strategy, the Inuit Regional Conservation Strategy, the Yukon Conservation Strategy, the Northwest Territories Sustainable Development Strategy, the sustainable development activities of the Canada/Man and the Biosphere Northern Working Group, and the federal government's Arctic Environmental Strategy.

The Potential of Science and Technology

Northerners are no strangers to science and technology. Aboriginal people have inhabited Arctic regions for thousands of years despite the extreme harshness of the environment and the limited resources available. What gave them the edge to survive was their technology. For example, the invention of the bow drill about 1000 years ago allowed the Inuit of northern Canada to better use the material resources at hand to make the implements they required, whether it was a harpoon head or a sled runner. With snow covering the land and the sea frozen for at least eight months of the year, it was the dog team and sled that enabled extended travel to obtain distant goods, such as musk-ox horn or wood. The snow house provided the ideal shelter for a semi-nomadic hunting people. And traditional techniques for processing animal skins allowed the provision of not only warm clothes and bedding essential in the cold Arctic climate, but also bags and packs, tents, kayak covers, lashings for the sleds, traces for the dogs, lines for the harpoons and spears, water buckets, and many other articles.

Integrating aboriginal knowledge with modern technology resulted in a much-improved floe-edge boat.

Mike Beedell

The Snow House

The snow house was the habitual winter shelter for the Inuit living in the Canadian Arctic east of the Mackenzie River. It provided an ideal shelter for a semi-nomadic hunting people: the building material, snow, was at hand on arrival at a camp site, and the tools involved, a snow knife and shovel, were also used for many other purposes.

A snow house is constructed from a deep snow bank, containing firm snow of homogeneous consistency. Snow blocks are cut from the bank with a snow knife, a long knife with rounded edges to reduce resistance in cutting the snow. Originally snow knives were made from ivory; later single-edged steel knives were used. The first blocks are cut out to form a tunnel and are placed in an inward-leaning circle in such a way that the tunnel forms a below-ground doorway. Subsequent blocks are cut from inside this circle so the floor level of the house will be below ground level. A certain area inside the circle is left uncut to form an elevated sleeping platform.

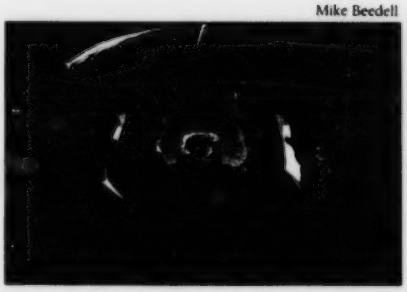
The first circle of blocks begins an ascending spiral. Blocks are added to the spiral, with each row inclining more inward. The roof blocks are almost horizontal, and a final horizontal key block is inserted into the centre of the roof.

Holes between the blocks are plugged with snow and loose snow is shovelled up the sides of the house to provide greater insulation. The heat of a lamp inside the house melts the inner layer of snow on the blocks, and the resulting water is sucked into the snow walls where it freezes to make the house windproof and strong. Light is provided by windows of freshwater ice or the scraped and stretched gut of the bearded seal. A ventilation hole is cut in the roof.

The snow house is one of the greatest achievements of Inuit technology. Inuit appear to be the only people who have succeeded in building a dome without the aid of scaffolding. In fact, the shape of a snow house is not a spherical dome, but rather approximates a parabola. This is a shape modern engineering could not improve upon, since it reduces the outward pressure on the lower rows to the minimum.

The design of the snow house enables it to remain warm even though well ventilated — a vast improvement on a tent, which can only be heated if all openings are sealed. Because the entrance tunnel to the snow house is sunken, warm air inside the snow house can only exit via the ventilation hole in the roof. Cold fresh air is drawn through the tunnel at the same rate as stale warm air escapes through the ventilation hole. With outside temperatures of minus 40 degrees Celsius, temperatures inside the house range from minus five degrees on the sleeping platform to plus five degrees near the roof.

Mike Beedell



The snow house: unbeatable temporary accommodation at sub-zero temperatures.

There are many examples of successful applications of science and technology in northern communities. Some involve the integration of traditional aboriginal knowledge and technology with modern materials and production technologies. Others involve the newer, high-technology fields.

One such example is that of the Cree of the Waskaganish Band in northern Quebec. The Hudson's Bay boats that the Cree and Inuit have been using for years in northern Quebec are expensive, last only a few years, and can be swamped and sunk in the turbulent waters of James Bay. In the mid-1980s, the band approached Toronto-based Yamaha Motor Canada Limited about the possibility of jointly building boats. While the Cree had knowledge of the northern waters, Yamaha knew how to build boats. In Japan, Yamaha builds over 20 000 fibreglass boats a year, ranging from small sailboats to 30-metre coastal fishing vessels. Yamaha became interested in the project and sent an engineer from Japan to study the situation and work on a design. The resulting prototypes were sturdier and able to keep occupants drier than the existing boats; they could float even if filled with water. Subsequently, the Cree-Yamaha boat-building venture set itself up in an old government building and shipped in the necessary fibreglass, moulds, machinery, and other equipment. The Japanese taught the Cree how to make the boats they had helped design for James Bay. Less than a year after the first prototypes were built, the first Waskaganish-built craft rolled off the assembly line. Cree-Yamaha sold 75 of the boats in its first year, phased in a larger boat in the second, and in the last few years has seen a steadily increasing market for the boats in the James Bay area and beyond. At present, the enterprise employs nine people.

The Waskaganish Band is also looking into the viability of setting up a char aquaculture project. Their intention is to supply both local (wild fish populations having been polluted by mercury) and outside markets.

Another example is that of the northern Quebec Inuit's attempt to re-establish a commercial char fishery. Char has not been harvested in that area on a commercial basis since the collapse of the commercial fishery over 25 years ago due to depletion of stocks. Following a request from an individual Inuk who wished to establish a commercial fishery in Kaniqsualujjuaq, the provincial government granted a licence for a test fishery with a quota of 35 000 pounds. The Kuujjuaq Research Centre, the training organization established by Makivik Corporation for the Inuit of northern Quebec, was hired as consultant to monitor the test fishery and carry out a sampling program. The Inuit in the community selected sites for the study, based on their knowledge of the ecology of char in the area. A winter fishery was established using gill nets to harvest the char, and a fall harvest was established using fish weirs based on a design adapted from the Northwest Territories.

Local people have been hired and trained to do the tagging and survey techniques. The char is being marketed through an Inuit business in Kuujjuaq that acts as a central wholesaler and retailer for fish products for the region. The owner of the business is receiving training in smoking fish and in other aspects of the food business. The experimental fishery is now in its third year of operation and is considered a success. The project will not only help to establish a commercial quota, but will also provide useful basic scientific knowledge of the resource and the effect of commercial fishing on an unexploited fish population.

Another example is that of the Champagne-Aishihik Indian Band in Haines Junction, Yukon. This band is quick to identify opportunities and is always looking at ways to achieve import substitution. One such opportunity arose in building construction. At one time all the wooden building trusses had to be trucked in from Edmonton. Then the band established a truss manufacturing plant that has become very profitable. Aside from meeting the needs of the band's construction projects, the company sells to the Whitehorse market, and some trusses are sold as far away as Dawson City. The company is now hoping to expand its sales into Alaska.

Another opportunity arose when the truss plant started up — there was no heat in the building. The band constructed a chip-fired central heating plant that heats not only the truss plant and the maintenance shop for the company but also three other band buildings. The band now employs about 40 people in its truss and heating plants.

Processing Animal Skins

Animal skins were one of the most important materials in the economy of the Inuit. They provided not only the warm clothes and bedding essential in the cold Arctic climate, but also bags and packs, tents, kayak covers, lashings for sled runners, traces for dogs, lines for the harpoons and spears, water buckets, and many other articles. Traditional techniques for processing skins were vital to survival.

Caribou skins that were to be used for clothing first had any fat removed with a scraper made from the leg bone of a caribou, which was split and sharpened to a chisel edge, or with an ulu, a knife with a curved blade. The skins were then stretched and dried. Next they were softened by repeated scraping with a blunt scraper made from the upper end of a musk-ox scapula with the joint cut to form a handle. This scraping broke the fibres of the skins, which were softened further by wringing. Water was sprayed on them and they were rolled and put away for a day before being scraped again with the blunt scraper. Finally, the tissue under the skin was removed using a sharp scraper made from caribou antler with a small curved blade inserted into the end.

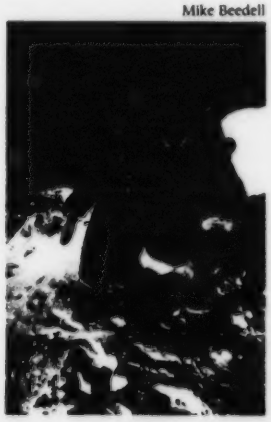
This processing made the caribou skins soft and flexible, almost like cloth. Unlike commercially tanned caribou skins, which tend to stiffen in the cold, skins cured in this way remain supple even at very low temperatures.

Seal skins were treated in a variety of ways, depending upon their intended use. Seal skins meant for clothing were first scraped with an ulu to remove all traces of blubber and flesh, then dried and stretched. The flesh side was then dampened with water and scraped with a blunt scraper until the skins were very soft.

Material for watertight boots was made by rolling up wet seal skins with the hair facing inwards. This made the skins ferment, after which the hair was removed with an ulu or sharp scraper. They were then dried and scraped until soft.

A fine white seal skin for use in the decoration of boots was processed by first removing the hair by fermenting and scraping. Then the skins were soaked in urine to remove the oil, and stretched out to bleach in the open air.

Mike Beedell



Traditional caribou skin parkas provide superb insulation in the cold Arctic climate.

The Champagne-Aishihik Indian Band has also established a computerized digital mapping service. Despite an initial setback, prospects are now looking up with potential contracts for the mapping of telephone trunk lines and local street maps for the city of Whitehorse. In addition, the band experiments with new technologies. Band members recently built a small hydroponics test plant to investigate the possibility of producing fresh vegetables for the Whitehorse market. To date, they have been testing spinach and lettuce and have found that the system has low energy and water requirements. The band is continuing to refine the process and after a few more test crops will be ready to build a commercial system that will be able to produce enough spinach and lettuce to supply the entire Yukon market. The small system will still be used to test new products and to improve the process.

The Changing Climate for Science and Technology Policy

Since the early 1970s there has been general agreement that Canada needs a northern science and technology policy directed at northerners' needs as well as national goals. The principle has been repeated whenever northern development has been discussed. At the 1972 Seminar on Guidelines for Scientific Activities in Northern Canada, sponsored by the Advisory Committee on Northern Development, working groups of scientists and specialists from the academic community, industry, and government concurred that scientific activities in the North should be directed at meeting the needs of northerners and particularly northern aboriginal people.[15] The Department of Indian and Northern Affairs' *Guidelines for Scientific Activities in Canada's North* (1978) took the position that northern scientific activities should balance northern and national goals.[16] The Science Council, in its 1977 report *Northward Looking: A Strategy and a Science Policy for Northern Development*, advocated a strategy of mixed development, using science and technology to support small-scale, community-based economic development and not, as was the usual practice, solely to support large-scale, non-renewable resource or industrial development.[17]

Yet almost 20 years after the 1972 seminar, we still do not have a science and technology policy directed at the economic development of northern communities. A 1987 report prepared for the Minister of Indian and Northern Affairs concluded that "real changes in approach to science programmes, involving the recognition of the linkages between scientific activities and local issues in the North, will be required before Canada can achieve a sustained, first-class, balanced polar science and research programme."[18] A 1988 report prepared by the Canadian Institute of International Affairs concluded that, despite well-meaning attempts in recent years to give science a northern orientation, the vast bulk of scientific work undertaken in the North continues to be initiated in the South in response to southern needs and priorities.[19]

Nonetheless, there is a growing recognition that achieving the goal of greater economic self-reliance will require the application of science and technology both to a greater extent and in somewhat different directions than formerly. In recent years, northerners have taken steps, at both government and non-government levels, to ensure that science and technology become components of long-term community economic development. For example, the territorial and provincial governments signed Canada's national policy on science and technology in March 1987. Also, the Yukon government announced the Yukon Science Policy in April 1986, signed the Canada/Yukon Memorandum of Understanding on Science and Technology in April 1987, and approved the Yukon Science and Technology Strategy in 1989. The government of the Northwest Territories created the Science Institute of the Northwest Territories in 1984.

At the non-government level the international Inuit community, acting through the Inuit Circumpolar Conference, is in the process of drafting an Arctic policy that has as one of its components an Arctic science policy. Also, the Cree of the Waskaganish Band in northern Quebec recently held a workshop on their economic development directions entitled "Science and Technology — Our Future." Similar workshops have recently been held in other northern communities. Makivik Corporation has given its

research department a new mandate that primarily directs its research to the commercial development of renewable resources. And the Champagne-Aishihik Indian Band in southwestern Yukon recognizes that the only way to survive in the private sector is to be up to date with the latest technology.

These steps represent a good start, the beginning of efforts to ensure that science and technology become components of economic development in northern communities. But there is still a long way to go. With northerners so determined to take control of their future, surely now is the time to assist those responsible for the development, refinement, and implementation of a science and technology policy directed at community-based sustainable development in the North.

2. The Challenge to Development

Despite Canada's status as an advanced industrial nation, many northern communities face economic conditions not usually seen outside the Third World. The Science Council believes that integrating science and technology into the development of these communities is a key to their future prosperity. What are the challenges? After extensive consultation with Canadians in the North and South, the Council identified the need to:

- raise awareness of science and technology through education and training;
- improve access to scientific and technological information that is both relevant and comprehensible to northerners;
- strengthen support for technology development, adaptation, and transfer; and
- increase contact and cooperation with northern residents of other circumpolar nations.

The Need to Raise Awareness of Science and Technology through Education and Training

A keen appreciation of the potential of science and technology to contribute to greater economic self-reliance exists in certain parts of the North. But science and technology are still far removed from the lives of most northerners, and unfamiliarity with science and technology is one of the main deterrents to their application in the economic development of northern communities.

This problem is by no means restricted to the North, or to the aboriginal population, but it is perhaps especially acute there. The problem is a lack not only of formal education but also of a scientific perspective, with its potential use as a basis for self-reliance and informed judgement. Moreover, in the North, there is widespread misunderstanding and suspicion about science and technology.

Northerners, and in particular aboriginal people, are acutely aware that in the past they have been used by scientists for purposes not their own. Some scientists who work in the North have developed excellent relations with northerners over the years, giving their knowledge to the community, training and employing people, and otherwise providing tangible evidence of the benefits of their work. Yet scientists are often perceived as advocates of government or industry initiatives that community residents have rejected. Furthermore, there is a perception that the misapplication of science and technology has created some of the major ecological problems threatening the North today.

This is not to say that there is an absolute rejection of change or innovation in northern communities. Northerners are quick to adopt what is evidently useful. But the highly structured methods of conventional science and technology are not always evidently useful.

The aboriginal people have a land-based experience that has been gained over generations. Their understanding of the world has for the most part been denied or denigrated, rather than respected and utilized. It is increasingly, if not yet adequately, recognized that aboriginal people have different but valid modes of explanation, and that education is necessary in order to bridge a gap rather than to fill a void.

Northerners are quick to adopt what is evidently useful.

Mike Beedell

Science Education and Technical Training: The Need for Local Control

The people of Nain, a predominantly Inuit community in northeastern Labrador, have little self-governing power and little control over important areas of their lives, including science education and technical training.

Problems in science education are apparent throughout the elementary and secondary levels. To begin with, science education follows the curriculum set by the province of Newfoundland and Labrador and is based on "white" and southern terms: local students, many of whom are not fluent English speakers, find it hard to understand the material, and, even if they can understand it, find it irrelevant to their way of life. Other problems relate directly to the inadequacy of funding for science teaching in Nain. Curriculum aids, audiovisual equipment, and library resources are in short supply and it is next to impossible to develop the hands-on teaching methods that have proved effective elsewhere.

Given this background, it is not surprising that students in Nain have little interest in science and, lacking Inuit role models and clearly defined career options, seldom see science as a possible career.

Technical and adult training in Nain does no better in meeting community needs, and many of the problems are funding problems. Programs are funded by Employment and Immigration Canada, but the eligibilty requirements of EIC-funded programs often prevent Inuit from participating. Some cannot work the minimum number of weeks required to attend a course, and courses sometimes conflict with seasonal activities.

Problems arise when training programs are conceived in the South without consultation with the community. A program designed by the Institute of Fisheries and Marine Technology for fishermen in northern Labrador failed because the videos on fishing-related subjects such as motor repairs, new fishing technology, and methods were in English. Moreover, the instructor was a southerner who was felt to be insensitive to the needs and culture of the community. Another program sent a large fishing boat to coastal communities to show people how to use new equipment and fishing techniques, but the people in Nain use mainly small fishing boats that cannot accommodate the equipment.

The problems the Labrador Inuit now experience in such areas as science education and technical training are similar to those of other northern aboriginal communities, particularly communities in northern Quebec, before their land claims were settled. The people of Nain hope to gain more self-governing power and control over these and other important areas of their lives when the Labrador Inuit Association reaches final agreement with the federal and provincial governments on their land claims. A framework agreement for land claims negotiations was reached early in 1990, and there are indications that final agreement may be reached within four years.

Education and training programs, for the most part, do little to improve the receptivity of northerners to the usefulness of science and technology. Northern elementary and secondary school systems generally adopt southern-style science courses. They are taught by southern teachers, who tend to stay only a short time in a community, and they are based on English scientific terms and concepts that have little meaning in aboriginal languages. For example, the Northwest Territories has traditionally piggy-backed on the Alberta curriculum, using the Alberta system and all its resource materials; the Yukon Department of Education has recently adopted the science and technology course from the British Columbia curriculum; and northern Quebec has traditionally used the southern Quebec curriculum.

Some recent and encouraging steps have been taken to develop new curriculum units at the elementary and junior-high levels to make science more relevant and understandable to northern students. The Baffin Divisional Board of Education in the Northwest Territories is creating a new curriculum for kindergarten to grade nine in which science is integrated into everyday life and is taught in the student's mother tongue as well as in English. The Kativik School Board in northern Quebec is also currently attempting to incorporate elements of the northern environment and traditional aboriginal knowledge into the science program for its elementary levels. Such approaches are moving in the right direction. However, they are not yet widespread.

In addition, schools, especially those in remote communities, lack such facilities as laboratories, equipment, and teaching resources. Also largely lacking is home support in the form of books, educational materials, and parental encouragement. Many of the parents of today's aboriginal children have an ambivalent attitude towards education: they want their children to get an education, but they are concerned that the schools are robbing their children of their culture. The children sense this concern, and it is reinforced when the school system appears insensitive to their traditional knowledge, beliefs, and values.

Under these circumstances, it is not surprising that northern, and in particular aboriginal, students see science as a foreign body of knowledge, with little relevance to the realities of community life. Neither is it surprising that an inordinate number of northerners lack the basic academic education needed to develop any adequate skill levels in scientific areas.

Few of those northerners who do graduate from high school undertake higher education in the fields of science and technology. Part of the reason is their lack of suitable qualifications and prerequisites. However, another problem is that there is no university in the North, and no comprehensive university program available to northerners in their own land. Yukon College, Whitehorse, and Arctic College, Yellowknife, and their satellite campuses offer limited post-secondary technical and academic programs, and some southern universities offer a selection of programs or courses in the North, either through distance education or at field stations in northern Canada. But these are selective parts of a university curriculum and as currently developed do not constitute a "university system" in northern Canada.[20]

Although a few northerners manage to travel the hundreds, perhaps thousands, of miles necessary to pursue post-secondary education, many find it too difficult. The financial burden is great, particularly for those who have families to support. As a result, technical training in a person's own community is often the only feasible option. One of the most successful science and technology training programs in the North is the Renewable Resources Technology Program at the Thebacha Campus of Arctic College. Variations of this program have been developed for the eastern Arctic, and tried in Labrador as well. The keys to its success are that it was locally developed, deals daily with science and technology issues at the community level, and integrates conventional science and technology with traditional aboriginal knowledge. Jurisdictions without such a program are eager to have one.

In addition, governments sponsor a long list of training and employment programs. Some are national programs, while others are targeted specifically at aboriginals. Employment and Immigration Canada (EIC) has the statutory mandate for training and employment (job creation) programs, but in recognition that the EIC approach based on

The Commercial Development of Wildlife Resources: Hampered by Lack of Data

The Labrador Inuit Development Corporation, the commercial development arm of the Labrador Inuit Association, was established to improve the economic life of Labrador Inuit. One of its business ventures, a commercial caribou hunt, has become an essential source of employment and income for the people of Nain.

The annual commercial caribou hunt and processing of carcasses lasts about three weeks and employs 15 hunters and up to 40 support and processing workers. Over this short period, the work is intense and provides much-needed cash. Hunters can earn up to $7000 during a time of year when there is little alternative employment.

The first commercial hunt, in 1985, was a modest pilot project directed toward marketing only within Labrador. In 1986 the corporation expanded marketing into Newfoundland. In the spring of 1988, it opened a large, modern facility in Nain with the capacity to process federally inspected meat for sale throughout Canada and the United States. By the end of 1988, over 85 per cent of the meat processed was sold outside the province. The corporation began to penetrate markets in Europe and Japan, and to plan for more secondary processing in Nain that would increase product value and create new employment opportunities.

In 1990 the caribou did not appear. The consequent loss of income meant severe economic hardship for the community. The failure of the 1990 hunt and the discovery of several caribou with diseased tongues point to the need for more research on the health, environmental sensitivities, migratory patterns, and population dynamics of the caribou. The Labrador Inuit Association and the Labrador Inuit Development Corporation are calling for the establishment of a caribou research centre in Nain.

Attempts to monitor the caribou have been sporadic, isolated, and underfunded. While caribou populations have historically followed a peak and crash cycle, the Labrador Inuit fear that the herd is under increasing pressures due to pollution and the low-level flying that has been taking place in the region. So little is known about caribou migration and population dynamics that no one knows whether the herd that approaches Nain each fall is the George River herd of 500 000 animals or the smaller Torngat herd, which is important for subsistence harvesting. Such information is vital when considering a fall hunt.

The Labrador Inuit Association has been instrumental in collecting and analysing much of the available data on the region's wildlife. It is currently involved in a research study of the health of the caribou herd. During the hunt, its wildlife technicians take organ and marrow samples that are sent to southern labs for analysis. The main objective is to determine the level of certain contaminants in key organs. The results are also useful in monitoring the general health of the herd, and are expected to shed light on the fact that caribou have been found starved to death although there was abundant food in the area. Research results are sent back to the communities and discussed with hunters, whose input on the hunt and health of the herd is invited.

The Labrador Inuit Association is also part of the tripartite steering committee of the Environmental Impact Review Panel that investigated the effects of low-level flying on the behaviour of the caribou herds. Caribou were fitted with collars equipped with satellite tracking technology that allowed easier and more accurate monitoring of the herd's movement. But too few collars were left operational after the study was completed to indicate whether the entire herd was moving or just individual animals.

The association is applying for funding for continued satellite tracking. It is also exploring the possibility of acquiring an advanced computer system for compiling information on wildlife management, such as seasonal locations, migration patterns, harvesting statistics, and trapping yields.

national, universal programs was not working well for certain regions or client groups, other mechanisms have supplemented EIC programming since the 1960s. For example, the Department of Indian and Northern Affairs now supports various training programs for status Indians and Inuit. Examples of successful government-sponsored programs include the Seaku Fisheries Training Program of Makivik Corporation, the surveying training program for the Fort Good Hope Band-Chevron joint venture, and the Native Resource Training Program of the Inuvialuit Development Corporation.

Generally, though, there are serious shortcomings in the training programs available at the upper and adult levels in the North. Little or no decision-making authority exists at the community level for establishing training priorities. Decisions on behalf of a community are usually made in larger northern centres or in the South by people who are not familiar with local needs and conditions. Consequently, the training priorities developed elsewhere are not always appropriate to a community's training needs. Moreover, gaining access to technical training programs is a continuing problem. Requirements, such as that anyone participating in the programs be unemployed for the previous 30 weeks, tend to direct funding to the chronically unemployed rather than to people who are recently out of school or who are developing good work experience.

A recent step by the federal government — the Canadian Aboriginal Economic Development (CAED) strategy — addresses, among other issues, the lack of technical training programs for aboriginal business development projects. A key feature of the CAED strategy is its emphasis on financially assisting the training and advisory services required by such projects. Under the strategy, Industry, Science and Technology Canada will fund training in the business skills (management, accounting, and technical expertise) required at the initial stages of a project, the Department of Indian and Northern Affairs will supplement EIC's Canadian Jobs Strategy Program with literacy, academic, and other basic skills upgrading, and EIC will fund the training needed after the start-up of a business development project. Additional funds have been allocated to the departments of Indian and Northern Affairs and Industry, Science and Technology to implement the strategy. To date, however, no additional funding has been allocated to EIC. Moreover, northern communities continue to have little influence in decisions about what types of training programs should have funding priority.

The Need for Access to Scientific and Technological Information that is both Relevant and Comprehensible to Northerners

The technology-based economic development of northern communities rests on adequate access to scientific and technological information. Not only must access be easy, but the information itself must be relevant and in an understandable form. So far, however, northerners' information needs have not been satisfactorily met.

Part of the problem is the bewildering multitude of sources of information about the North and of systems for transferring that information. At present, there is inadequate coordination and collaboration between data collection agencies within governments, the academic community, aboriginal organizations, and industry.

Moreover, much of the data in information systems have been generated by southerners and do not necessarily serve northerners' needs. Although efforts have been made in recent years to do scientific research that meets northerners' needs for information, the bulk of scientific work in the North continues to be initiated in the South in response to southern needs and priorities.

In addition, it is difficult to transfer new scientific and technological information between various parts of the North. For example, Makivik Corporation in northern Quebec is currently collecting accounts of the traditional knowledge system in an attempt to build up a large scientific and technological information base, but has had limited success in making the information available to others. Few good channels exist for east-west information exchange since the flow has traditionally been in a north-south direction.

Recently, steps have been taken to create a national polar information system.

In August 1988, the Minister of Indian and Northern Affairs announced plans to set up a Canadian polar research commission, noting that it would play a key role in the development and dissemination of polar knowledge in Canada, linking and focusing the work of existing institutions. The bill to create the Canadian Polar Commission was introduced in Parliament on 25 May 1990. In the meantime, five Canadian polar information centres have been working together, with funding from the Department of Indian and Northern Affairs, to design a detailed Canadian polar information system.

A single access point for specialized information about the Canadian North would undoubtedly help some northerners acquire such information. But the Canadian Polar Information System is being developed mainly for use by experts involved in polar research — not for members of the public in northern communities or people in northern businesses, schools, or government offices.

Northerners are often unfamiliar with the scientific concepts and methodologies that figure in most expert reports, and aboriginal people cannot easily relate these to the concepts and methodologies of their native knowledge and language. Moreover, printed reports are not necessarily the most effective way to provide scientific and technological information to northerners, particularly aboriginal elders. What is needed are people to play a liaison role — "middlepersons" who can obtain the information and interpret it directly to users.

Access to traditional aboriginal knowledge as well as to conventional scientific and technological information is crucial in order for northerners to participate fully in technology-based economic development, particularly resource-based development. However, the Canadian Polar Information System is unlikely to adequately incorporate indigenous knowledge of natural resources and the environment in the North because it is being designed primarily by southerners. This information can best be collected and incorporated into information systems by northerners themselves.

Cree-Yamaha Motor Enterprises Ltd.

A joint venture between the Cree of Waskaganish and Yamaha yielded a safer, sturdier boat for the turbulent waters of James Bay.

The Need to Strengthen Support for Technology Development, Adaptation, and Transfer

Technology-based economic development in the North is also restricted by the limited ability to develop technology locally, the difficulty of transferring technology developed elsewhere to northern communities, and the problems entailed in adapting technology developed in the South to northern conditions. In some areas of the North, particularly in the larger centres, individual northerners, aboriginal organizations, and governments have worked hard to direct both government and non-government support for business to technology-based development. This support has successfully engendered some locally owned and controlled enterprises.

For instance, aquaculture, hydroponics, and greenhousing projects have been initiated through the Yukon government's applied research, demonstration, and pilot projects program. Three more examples are the land surveying joint venture between the Fort Good Hope Band in the Northwest Territories and Chevron, partly funded by the Native Economic Development Program and the Special Agricultural and Rural Development Agreement Program of the former Department of Regional Industrial Expansion; the inshore scallop survey, arctic char responses experiment, and arctic char enhancement program of Makivik Corporation in northern Quebec, partly funded under the Canada-Quebec sub-agreement on fisheries development; and the boat-building joint venture between the Cree of the Waskaganish Band in northern Quebec and Yamaha, partly funded by the compensation monies received under the James Bay and

Northern Quebec Agreement. Nonetheless, support mechanisms, whether government or non-government, are used only sporadically by northerners for technology development, adaptation, and transfer.

Part of the reason is the inadequate design and delivery of the available support mechanisms. Northern businesses in general are poorly serviced by commercial lending institutions, first because of the cultural as well as geographic distances involved, and second because of the higher risk of lending in the North compared to the South. As a result, support from the government is often the only feasible option for technology-based initiatives. Although the few land claims that have been settled have brought considerable new wealth into northern regions, their contribution to economic development is at an early stage.

Government-sponsored mechanisms that northerners may, in principle, use to support technology development, adaptation, and transfer include aboriginal economic development programs, programs that are directed at improving economic opportunities in specific regions and apply to both aboriginal and non-aboriginal people, and science and technology-specific support programs. Such mechanisms are numerous, confusing, and poorly coordinated between and within the different levels of government.

Moreover, many of these programs are located and designed in the South and apply southern standards and conditions. Those delivered in the North tend to be based on southern models and administered by southerners. Few northerners, particularly those in the smaller, more remote communities, know of their existence, and even fewer know how they could be used. Although some of the northern economic development corporations and various government-initiated projects have the operational resources to fulfil the rigorous proposal requirements, individual northerners rarely have the necessary resources or skills. Furthermore, the criteria used to decide the allocation of funds and total funding available are often suited more to the South than the North. Most require northerners to raise substantial amounts of money and guarantees. However, both capital costs and risks are higher in the North than in the South, and this puts a tremendous burden on would-be entrepreneurs.

In addition, few government-sponsored mechanisms are targeted specifically at technology development, adaptation, and transfer. The only federal program targeted specifically at supporting technology-based initiatives that is at all regularly used for northern development is the Industrial Research Assistance Program (IRAP) operated by the National Research Council. In the past, IRAP field staff rarely visited northern communities and very few IRAP-supported projects were conducted there. This has recently changed and the National Research Council is beginning to appoint permanent field officers in the North. Although a variety of federal, provincial, and territorial government-sponsored economic development programs are broad enough to include technology-based initiatives, it is up to the discretion of program managers as to how flexible they will be in the promotion and support of such initiatives. Little in-house capability exists in government departments, particularly at the territorial level, for evaluating the R&D aspects of proposals. Program managers are not required to have degrees or experience in science and technology.

Another reason for the infrequent use of support mechanisms is northerners' lack of sustained interest in technology-based economic development — a lack of interest stemming partly from their unfamiliarity with the potential of science and technology to contribute to greater economic self-reliance and partly from their general lack of control over the technology-based economic development projects that do take place. Most projects tend to be managed by outsiders, either government personnel or independent consultants, because of the shortage of indigenous business and management skills in the North. Northerners are recruited to carry out specific tasks, but have no sense of ownership or control over a project, no understanding of the processes and problems involved. As a result, development projects tend to occur on a one-time basis and future locally-generated initiatives are rare.

Some governments have recently moved to correct the problems. For example, in 1989, the Yukon government approved the Yukon Science and Technology Strategy, prepared by a committee with representatives from the federal government, the Yukon government, the Yukon Science Institute, and the Council for Yukon Indians. Under its

CAED strategy, the federal government has begun to coordinate aboriginal economic development programs delivered through the departments of Industry, Science and Technology (ISTC) and Indian and Northern Affairs (DINA).

ISTC, through its Aboriginal Economic Programs, provides financial and developmental assistance to all aboriginal business development activities, including feasibility studies, business capitalizations, and aftercare of business start-ups. This replaces the aboriginal programming offered under the former Department of Regional Industrial Expansion's Special Agricultural and Rural Development agreements, Northern Development agreements, the Native Economic Development Program, and DINA's direct contributions to businesses.

DINA is responsible for providing funding and advice to enable aboriginal community-based economic development institutions to deliver government programs to their constituents, and for helping Indian and Inuit communities to negotiate access to nearby resources, attract developers to invest in community-owned resources, or establish agreements with developers of large-scale projects that offer employment and business benefits. DINA continues to administer direct loans through the Indian and Inuit Economic Development Fund when no effective service is provided by an aboriginal capital corporation.

The CAED strategy is a step in the right direction. It is intended to provide a one-window approach to federal aboriginal economic development programs. Moreover, its potential for increasing technology-based initiatives is significant. The components of the strategy described above, combined with the component that funds training in business skills such as management and accounting (described on page 27), are designed to address all stages of aboriginal business development. Nevertheless, the CAED strategy is a national strategy serving national objectives that are not necessarily congruent with northern objectives, it has a national budget that is to be used according to national priorities, with no specific allocations for northern regions, and it is centrally administered in the South. In addition, the CAED strategy is a demand-driven program, which sits back and waits for users to apply.

The Need for Increased Contact and Cooperation with Northern Residents of Other Circumpolar Nations

Because northern regions of circumpolar nations share similar economic development problems, Canada's northerners can benefit from the experiences of other countries in technology-based northern development. For example, much can be learned from Lapland and the Soviet North about commercial food production technologies. Greenland's fisheries offer an opportunity to learn well-developed harvesting and processing methods, while Norway and Sweden could provide pointers on raising reindeer.

Some cooperation has taken place or is in progress. An example is the Labrador Inuit Development Corporation-Faroese joint venture in shrimp fishing, in which the Labrador corporation benefited from the expertise and state-of-the-art vessels of the Faroe Islanders. Another example is the Makivik Corporation-Qikiqtaaluk Corporation-Faroese joint venture in shrimp fishing. Nonetheless, such direct cooperation at the level of the residents does not occur often.

Canada's cooperation with its northern neighbours in the area of science and technology has increased steadily in the past decade, and a variety of mechanisms and arrangements have been developed. The federal, provincial, and territorial governments are signatories to numerous bilateral and multilateral agreements that include cooperation in polar science and technology. One example is the Canada-U.S.S.R. Arctic Science Exchange Program of 1984, which was recently incorporated into the Agreement on Cooperation in the Arctic and the North signed in November 1989 by Canada and the U.S.S.R. Six more such initiatives are:

- the Canada-Denmark Marine Environmental Cooperation Agreement of 1983 for sharing scientific information and responsibility for action to protect the ecosystems in the waters of Baffin Bay and Nares Strait;
- the 1983 Memorandum of Agreement between Canada and Finland on marine transportation technology;

- the Canada-United States Agreement on Arctic Cooperation, which provides for the sharing of research information in order to enhance the understanding of the marine environment;
- the 1989 Memorandum of Cooperation between the government of the Northwest Territories and the Greenland Homerule Government, which covers four activities — fisheries, wildlife, education and culture, and tourism;
- the 1988 understanding between Quebec and the Russian Soviet Federated Socialist Republic on economic, technological, and cultural cooperation; and
- the 1989 understanding between Alberta and the Russian Soviet Federated Socialist Republic on cooperation and exchange in economic, technological, sports, and cultural fields.

At the non-government level, Canadian scientists participate in a number of international bodies concerned with Arctic science, such as the Comité Arctique International, established in 1979 to improve understanding of the Arctic. Others include the Arctic Ocean Sciences Board, established in 1984 to advance scientific knowledge of the Arctic Ocean and adjacent seas, the Northern Sciences Network of the UNESCO Man and the Biosphere Program, formed in 1982 to bring the benefits of the MAB approach and its research and information program to issues of environmental protection, socioeconomic development, and resource management in cold regions and high latitudes, and the recently created International Permafrost Association for organizing scientists investigating permafrost into a professional society. Another recent initiative is the agreement signed in August 1990 by representatives of the eight Arctic-rim countries to establish the International Arctic Science Committee to promote international cooperation in and coordination of scientific research in the Arctic.

Also, the international Inuit community, acting through the Inuit Circumpolar Conference, is drafting an Arctic policy that has as one of its objectives the promotion of international cooperation in Arctic research. In addition, the Canada/MAB Northern Working Group, the Canadian arm of UNESCO's Man and the Biosphere Northern Sciences Network, was recently set up to provide a network for northern Canadians to communicate with one another and with other circumpolar nations. The group's primary focus is on sustainable development.

The legitimacy and good intentions of these various organizations and programs are not in doubt. But with some exceptions, most have done little to meet the need of Canada's northerners for direct contact with other northern people to see first-hand what they are doing and how they are doing it. At present, the cooperation that does take place usually occurs between government officials and between institutional representatives who act as intermediaries on behalf of the people of the North. Moreover, the emphasis is on international cooperation in scientific research. That is important to the solution of social and environmental problems in the North. But what the North now could benefit from is greater international exchange and cooperation in applied technology.

Developing Science Programs for Northern Students

The Kativik School Board, which has jurisdiction over elementary, secondary, and adult education throughout Nunavik (all of Quebec north of the 55th parallel), is facing the challenge of making science education more relevant to northern students and basing it on Inuit culture and language.

Before the James Bay and Northern Quebec Agreement of 1975, Nunavik schools were under southern jurisdiction and had southern-style programs taught by southern teachers. The land claims settlement provided for establishment of a regionally governed board. The Kativik School Board consists of a councillor from the Kativik Regional Government and one commissioner from each of over a dozen municipalities where Nunavik's 5600 Inuit live. It has introduced many changes. Many teachers now are Inuit and in most schools the teaching in the early primary levels is entirely in Inuktitut.

Among the board's tasks is the development of programs and educational materials for primary and secondary schools to replace the southern-based material used in the past. The board has established a curriculum development centre in Montreal, which has been working in various areas, including science education, for several years.

The new science courses the board put together seven years ago for primary levels 3 to 7 differed only superficially from the earlier, southern ones. Southern references in educational material were changed to northern ones — for example, polar bears were discussed instead of brown bears. But the southern writers did not have sufficient understanding of northern culture to select concepts and present them in ways that would be more appropriate for northern children.

When the board turned to revision of the science programs for primary levels 1 and 2, there was more input from Inuit teachers. Since these classes are taught entirely in Inuktitut, science terms and concepts had to be translated. The board soon realized that a much broader approach than just direct translation was required — an approach similar to the one employed in the development of their math and social studies programs.

The board had concluded that education in these subjects should begin from the children's own cultural and language perspective. Understanding the language and concept development of Inuit children had been critical. When given tests with logic blocks, Inuit children sort them differently than southern children. Basic concepts of social relationships are not built up starting with the "me" and "I" of the southern world.

In developing new math and social studies programs, the board started by providing courses for Inuit teachers to help them acquire a better understanding of the content areas. Then teachers and subject counsellors worked with Inuit elders to define relevent concepts and content areas based on Inuit language and culture. Finally, teachers and counsellors developed the detailed programs and changed the teaching style to make it more activity-centred.

Development of an effective primary science curriculum is demanding a similar effort. This is of necessity a long process. At its core is the development of people — teachers, elders, and counsellors — who have the knowledge and skills to work effectively together. It took two and a half years for the board to develop its program unit in social studies for levels 1 to 4.

The board believes that by basing science education at the primary level on concepts from traditional Inuit knowledge and culture, the program will establish a foundation on which northern children can develop a strong understanding and appreciation of scientific knowledge.

3. Directions for the Future

The successful integration of science and technology into the daily life of northern communities requires northerners both to initiate and control the process of integration. Northerners themselves can best identify their own needs, and develop strategies to respond to these needs in a way that makes sense to them. Experience has shown that the alternative — paternalistic approaches in which control is maintained by outside organizations — results in temporary gains at best.

New approaches are needed to science education and technical training, to the collection and dissemination of scientific and technological information relevant to northerners, to supporting technology development, adaptation, and transfer, and to circumpolar cooperation. Most of the following recommendations are geared towards identifying the institutional changes that will facilitate these new approaches. Other recommendations aim to ensure that northern organizations are better focused on science and technology. The detailed implementation of these recommendations is best left to northerners, in consultation with relevant government departments.

Science Education and Technical Training

Perhaps the most important key to increasing the use of science and technology lies in raising awareness of their usefulness. This requires the widespread adoption of new approaches to science education and technical training. Science education and technical training programs must be located in the North and developed and delivered by northerners.

This is the long-term solution. Northerners are currently limited in their capacity to design and deliver science education and technical training programs that will enable graduates to participate fully in the northern marketplace, let alone the national or global marketplace. Until this capacity is better developed, outside expertise and resources will continue to be required. For the immediate future, the answer lies in a more balanced partnership between northerners and southerners, in which northerners assume increasing control over the design and delivery of local science education and technical training programs. In particular:

1. **More local school boards should be established with jurisdiction over elementary, secondary, and adult education in northern regions.**

These boards could be set up under the provisions of land claims agreements — as was the case with the Kativik and Cree school boards set up under the James Bay and Northern Quebec Agreement — or under the provisions of territorial and provincial education acts, such as the newly revised Yukon Education Act.

To further strengthen local control over science education and technical training:

2. **Federal, provincial, and territorial government departments with responsibilities for northern education and training should have northern, including aboriginal, representation on staff.**

In addition:

3. **The design and delivery of technical training programs should be a joint responsibility of northern community economic development organizations, appropriate federal, provincial, and territorial government departments, and northern colleges and adult education centres.**

The ineffectiveness of the education system in the area of science and technology indicates wider problems. The education system as a whole has not met the needs of northerners, in particular the aboriginal population. For education to be effective, the schools must help northern students to see education as a complement to their own knowledge and culture, not as a threat. The education system must recognize the value of the students' knowledge and culture and use these as the starting point for education.

Building Northern Capacity to Control and Participate in Scientific Research

The Makivik Corporation, which was established under the James Bay and Northern Quebec Agreement to represent the collective interests of the Inuit of Nunavik, is vitally concerned with changing Inuit attitudes toward science, and increasing Inuit participation in and control of scientific research to ensure that it responds to the needs of the region.

Many activities to this end are carried out by the Kuujjuaq Research Centre, which the corporation established in 1981 to act as a centre of scientific activity and influence for the region. Scientific efforts at the centre are concentrated in two areas:

- providing training for Inuit in scientific research methods; and
- conducting projects to bridge the gap between scientific knowledge and methodology and traditional Inuit knowledge.

Training at the centre is conducted on a one-to-one basis, with each research trainee teamed with a scientist. Some are trained for positions within the centre itself, while others are hired and trained as field workers for specific research projects.

The centre bridges the gap between traditional Inuit knowledge and scientific knowledge and methodology by involving local Inuit from start to finish in carrying out its research work. Centre personnel discuss plans and results with community members, obtain their input, and issue summary reports in Inuktitut. Their knowledge and experience are valued inputs. For example, when the centre and the Kativik Regional Government embarked on a project to increase the number of spawning char in the lakes, they began by interviewing local hunters on the ecology of the char in the area. When the program was conceived, it was expected to concentrate on removing major obstacles to char migration in order to open up new river systems to the char. The interviews resulted in a change of direction. Instead of opening up new systems, the project shifted to improving existing ones.

The centre's knowledge of the region and its rapport with community members often makes it the most effective agent for conducting research on the region for government departments. Government contracts, in turn, provide the centre with more opportunities to interact with communities and to hire and train Inuit field workers.

Interviews with hunters and other Inuit have also allowed the centre to build a substantial record of their knowledge of the land, the wildlife, and other resources. These reports have been used by the Kativik School Board in developing material for their science program.

In spite of these successes, progress in meeting the corporation's objective of building Inuit participation and control has been much slower than originally envisioned.

Some Inuit have become excellent technicians, and large expenditures on training have helped to increase the number of successful trainees. The three staff positions for technicians at the centre are all filled by Inuit. However, few have taken the next step to designing research projects, analysing data, and writing reports. So far, the three staff positions for biologists at the centre have been filled by non-Inuit. Too few Inuit leave high school with the necessary basic skills in language, math, and science to handle higher education in science. Representatives of Makivik Corporation stress that further technical training is not the answer. Becoming a scientist requires higher education in science. Real regional control will be possible only when the region has a core of Inuit capable of fully understanding, working with, and adapting scientific and technological research to respond to the needs of the region.

The following two recommendations are strategies for achieving this objective in science education and technical training:

4. **Local school boards in the North should ensure that elementary and secondary science education courses focus on the science of the northern environment and that science is taught in an appropriate cultural context.**

For example, science courses could incorporate traditional aboriginal knowledge, adopt outdoor, "hands-on" methods of instruction, and be delivered in the students' mother tongue. This would involve aboriginal elders and aboriginal teachers in the design and delivery of science courses. An example of a school board currently attempting to do some of the above is the Kativik School Board in northern Quebec.

5. **Northern colleges should offer more scientific and technological training programs that are both culturally appropriate and deal with scientific and technological issues at the community level.**

An example of such a program is the Renewable Resources Technology Program at the Thebacha Campus of Arctic College.

Finally, science education and technical training programs should, wherever possible, be in the community of the students or trainees. Wherever this is not possible, distance education must be available. Moreover, there must be sufficient educational support in the form of laboratories, equipment, and especially teachers — more of whom must be northerners, including aboriginal northerners. To meet these goals:

6. **Federal, provincial, and territorial governments, in consultation with local school boards, northern colleges and adult education centres, and community economic development organizations, should ensure adequate funding for:**
   - **science education and technical training programs in northern communities;**
   - **delivery of distance education and training to northern communities;**
   - **expanded development of science education program materials for northern regions;**
   - **training of northern, including aboriginal, science teachers.**

The Kativik School Board sets an example with many Inuit teachers and by teaching early primary levels almost entirely in Inuktitut.

Mike Beedell

Northern Scientific and Technological Information

If northerners are to harness science and technology to achieve greater economic self-reliance, they must have adequate scientific and technological information. The Canadian Polar Information System will do much to help northerners access the northern scientific and technological information that is currently stored in a multitude of information systems in Canada and abroad. However, northerners must be able to obtain this information in a form that is useful and comprehensible. To this end:

7. **Federal, provincial, and territorial governments should strengthen those organizations operating in the North that play a liaison role between information systems and northerners; in other words, those organizations that obtain available scientific and technological information and interpret it directly to northerners.**

Examples of existing organizations that play this role include the Science Institute of the Northwest Territories, the Yukon Science Institute, the Okalakatiget Society in northern Labrador, and the National Research Council through its Industrial Research Assistance Program.

Aboriginal Participation in Scientific Research: Improving the Information Base

Helping Inuvialuit of the Inuvialuit Settlement Region become full participants in the changing northern society is the overriding goal of the Inuvialuit Final Agreement of 1984. This includes finding ways for Inuvialuit to participate as equals in the management and implementation of scientific research undertaken in their region.

The Inuvialuit recognize the value of work carried out by trained and experienced scientific researchers. But they want their own traditional knowledge and practical experience of the land and its resources to be valued as well. They believe that only by acknowledging and respecting each other's contributions can the Inuvialuit and the scientific community work together to develop a truly comprehensive approach for research addressed to the priorities and needs of their society.

Under the Inuvialuit Final Agreement, five joint management advisory committees were created to foster cooperation between government and Inuvialuit in matters affecting wildlife resources and the environment in the Inuvialuit Settlement Region.

One of these is the Fisheries Joint Management Committee. The committee, which began operations in 1985, has two members appointed by the Inuvialuit Game Council, two members from the federal Department of Fisheries and Oceans, plus a chairperson.

The committee advises the Minister of Fisheries and Oceans on the management of fisheries in the region. Areas for advice include the establishment of Inuvialuit subsistence quotas for fish and marine mammals, and the collection and review of information on the status of fisheries in which Inuvialuit have an interest.

The committee also manages research programs on its own, including some that were formerly handled by the Department of Fisheries and Oceans. One of these is monitoring the beluga whale harvest in the Mackenzie estuary. Inuvialuit hunters hired by the committee do the monitoring and sampling field work. They record the number, sex, and size of the landed whales and take biological samples that are sent to Fisheries and Oceans for analysis.

From the time the Fisheries Joint Management Committee became fully operational in 1987, it was clear to members that the joint approach would work only if it reflected a cooperative relationship not just within the committee but with Inuvialuit communities throughout the region. Therefore, effort was put into building strong links with people in the communities and involving community organizations in the process of research and wildlife management. These efforts have had valuable results.

People in the communities now do their own basic inventory research on fish and marine mammal stocks. The Department of Fisheries and Oceans has provided training in sampling methods. Now community members provide the department with the data required to carry out analysis of fish and mammal populations. In Holman, the local Hunters and Trappers Committee runs its own fish population sampling project. The next step will be for Hunters and Trappers Committees in the region to take over responsibility for analysis of the samples as well.

But this would be only part of the solution. For information to be useful, it must be relevant to northerners' needs and priorities. At present, there are serious deficiencies in the available data on the northern environment and resources, particularly renewable resources — a problem due largely to the scarcity of research geared to meeting northerners' needs for scientific and technological information. To improve the scientific and technological information base for northerners:

8. **More local organizations should be established to carry out scientific research in northern regions.**

For example, research organizations could be established under the provisions of land claims agreements, as was the case with the Renewable Resources Development Department of Makivik Corporation set up under the James Bay and Northern Quebec Agreement. Alternatively, research organizations could be set up under provincial or territorial governments, as was the case with the Science Institute of the Northwest Territories set up by the government of the Northwest Territories.

Furthermore:

9. **The Canadian Polar Commission, in consultation with local scientific organizations, should encourage southern scientists to do research that meets northerners' needs for scientific and technological information.**

This recommendation could be implemented by, for example, initiating and supporting conferences, seminars, and meetings, and by sending newsletters to universities.

The incorporation into the Canadian Polar Information System of northern, in particular aboriginal, knowledge of northern resources and the environment would also improve the knowledge base. Because such information is best collected and integrated by northerners,

10. **The Canadian Polar Commission, in consultation with relevant northern organizations, should ensure that northerners have an opportunity to participate in integrating indigenous knowledge into the Canadian Polar Information System.**

Some northern organizations are already involved in collecting accounts of traditional aboriginal knowledge. Nevertheless, the task is formidable given the extent of the knowledge, the vast area of the North, and the different languages and subcultures involved.

Local hunters and fishermen are a storehouse of information on the land, the wildlife, and other natural resources.

Mike Beedell

Better access to information recently acquired by local scientific organizations would also improve the knowledge base for other northern regions. However, few good channels exist for exchange of information between northern regions. Therefore:

11. **The Canadian Polar Commission, in consultation with relevant northern organizations, should foster east-west exchange of recently acquired scientific and technological information, both conventional and traditional.**

This could be accomplished by, for example, initiating and supporting workshops and seminars in northern regions in which representatives from different northern communities across Canada could participate.

Support for Technology Development, Adaptation, and Transfer

To facilitate technology-based economic development in northern communities, northerners need access to government support programs for technology development, adaptation, and transfer. These programs must be coordinated both between and within levels of government, and, for maximum effectiveness, designed and delivered by northerners. But until northerners and their community

Building Northern Capacity to Control Technology-Based Economic Development

How can northerners build their capacity to develop, adapt, and transfer technology on an on-going basis? The Champagne-Aishihik Indian Band in the Yukon believes the answer lies largely in using the following set of principles when evaluating and pursuing technology-based economic development projects:

- a project should if possible address a need within the community;
- one or more band members should have some expertise in the technology to be applied;
- the technology used should be of a type and on a scale that allows the band to control the development of the technology and the required training;
- on-the-job technical training must be an essential component of a project from the start;
- the project must demonstrate that it is heading towards viability; and
- the chief, the council, and those directly involved with running the project must foster a confident and innovative approach to technology among band members working in the project.

The band has had considerable success in developing, adapting, and transferring technology for economic development. Moreover, the application of technology has clearly contributed to the business success of their development initiatives. Their approach stands in sharp contrast to that of most other northern groups, whose development projects tend to be largely under the control of outsiders.

Businesses supported by the band provide a range of training opportunities. A construction company offers opportunities for unskilled band members to get a job and receive on-the-job training. A computerized digital mapping project gives trainees an opportunity to become involved in sophisticated areas of computer application, and to develop confidence in their ability to work with and develop technology. These trainees are encouraging role models for other young band members, who have been accustomed to seeing technology only in the hands of non-aboriginals.

These and other business development projects have made the band's youth aware of the positive aspects of technology and given them the confidence to pursue technical training. Those involved in the projects are developing a sense of pride in being among the leaders in the development, transfer, and adaptation of technology in the Yukon. Their confidence permeates their approach not only to technology but to the whole process of economic development.

economic development organizations have the expertise and resources to perform such functions:

12. **The design and delivery of government-sponsored support for technology development, adaptation, and transfer should be a joint responsibility of northern community economic development organizations and appropriate federal, provincial, and territorial government departments.**

In addition:

13. **Community economic development organizations and appropriate federal, provincial, and territorial government departments should ensure that government support is more strongly oriented to technology-based initiatives.**

One of the greatest barriers to sustained interest in using technology support mechanisms is the shortage of northerners qualified to manage and provide continuity for technology-based economic development. As more northerners acquire the necessary business and management skills, more role models will become available to provide leadership and inspiration to others. To build the needed skill base:

14. **The design and delivery of business management training programs should be a joint responsibility of community economic development organizations, appropriate federal, provincial, and territorial government departments, and northern colleges.**

The three recommendations above, as well as recommendation 3, rest on the existence of local community economic development organizations. Thus the Council recommends that:

15. **Local community economic development organizations should be set up where they do not already exist.**

Such organizations could be established, for example, under the provisions of the Department of Indian and Northern Affairs' CAED strategy.

Circumpolar Cooperation

The bridging function of governments and scientists in transferring international scientific and technological knowledge to the North is well respected and should continue. However, northerners should have first-hand contact with other northern peoples to stimulate ideas for new technology-based ventures, technology applications, and ways of marketing: no intermediary can substitute for northerners' own perceptions or for their sense of what is interesting, important, or worth pursuing.

Once the desire exists to put an initiative in place, intermediaries have a role to play in securing the knowledge required to make the initiative a success. But intermediaries should not drive the system; they should support the decisions made by northern communities and regions and respond to their expressed needs.

The following recommendations are geared towards achieving greater cooperation and exchange between northern peoples:

16. **Canadian northern groups, with the support of the federal, provincial, and territorial governments, should work towards establishing more circumpolar organizations whose purpose is to facilitate regular meetings of northern peoples.**

One existing circumpolar organization, the Inuit Circumpolar Conference established by Inuit from Canada, Greenland, Alaska, and the Soviet Union, already arranges regular meetings between the circumpolar Inuit community. It actively promotes international cooperation in scientific research on socioeconomic issues, and its activities have found support in the policies of several Arctic nations.

The federal, provincial, and territorial governments are already signatories to numerous bilateral and multilateral agreements that include cooperation in polar science and technology. But such agreements have done little to facilitate direct contact among northern peoples. Thus:

17. **Bilateral and multilateral agreements should be enhanced to include pilot projects enabling direct contact and cooperation among circumpolar organizations in areas designated by northerners to be of particular importance.**

The pilot projects might involve circumpolar trade exhibitions and fairs in which northern people and their organizations could participate directly.

Part of the mandate of the Canadian Polar Commission will be to enhance Canada's international profile by fostering international and domestic liaison and cooperation in circumpolar research. The commission will likely aid Canadian scientists involved in polar research. But its impact on scientific and technological cooperation among northern residents is less certain. Therefore:

18. **The Canadian Polar Commission should foster direct contact and cooperation among circumpolar organizations as well as among scientists involved in polar research. The emphasis should be on international cooperation in applied technology, as well as scientific research.**

At present, few direct transportation links exist between circumpolar nations, making contact between circumpolar peoples difficult and costly. To improve this situation:

19. **Northerners, with the support of the federal, provincial, and territorial governments, should explore ways to improve direct transportation links between circumpolar nations.**

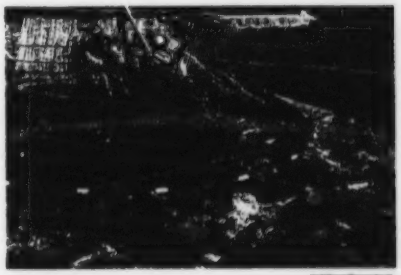
4. Getting Started

The Science Council strongly believes that northerners themselves must take the initiative to increase the application of science and technology in the economic development of their communities. Thus, the recommendations in this report focus on the institutional changes needed to help northerners gain some control over the process of integrating science and technology into their daily lives. There are some encouraging signs that governments are trying to devolve some control to northerners. The Council urges that this process be given higher priority.

Individual northern communities have different options regarding how best to bring about the required institutional changes, but they all face the same challenges. All should take action to raise local awareness of the usefulness of science and technology, improve access to scientific and technological information that is relevant and comprehensible to northerners, enhance support for technology development, adaptation, and transfer, and increase contact and cooperation with northern residents of other circumpolar nations. A useful first step would be for residents of northern communities to hold workshops to compare experiences with and ideas about science and technology-based economic development, and to tailor the recommendations contained in this report to their communities' needs. Workshops are an excellent means of developing the vision, the common goals, and the strategic planning needed before other steps can be taken.[21] Thus, the Council has one final recommendation:

20. **Northern communities should hold workshops to discuss the most appropriate means of implementing the recommendations contained in this report.**

Northerners need to share ideas about ways to integrate science and technology into economic development.



Mike Beedell

Notes

1. A.M. Maslove and D.C. Hawkes: *Canada's North, A Profile* (Ottawa: Statistics Canada, 1990).
2. Ibid.
3. Peter Usher and Frances Abele, "Danger to the North," in *Policy Options* 11, no. 1 (Jan.-Feb. 1990).
4. See, for example, *Newfoundland Royal Commission on Employment and Unemployment: Building on Our Strengths*, final report of the Royal Commission on Employment and Unemployment (St. John's, 1986).
5. Indian and Northern Affairs Canada, *A Northern Political and Economic Framework* (Ottawa: Minister of Supply and Services Canada, 1988).
6. Ibid.
7. Government of the Northwest Territories, *Direction for the 1990s* (Yellowknife, February 1988); Yukon Government, *Yukon Economic Strategy* (Whitehorse, 1988).
8. Indian and Northern Affairs, *A Northern Political and Economic Framework*.
9. Indian and Northern Affairs Canada, *Comprehensive Land Claims Policy* (Ottawa: Minister of Supply and Services Canada, 1987).
10. Indian and Northern Affairs, *A Northern Political and Economic Framework*.
11. Yukon Government, *Yukon Economic Strategy*.
12. Peter Jull, "Devolution and Division," in *Running the North* (Ottawa: Canadian Arctic Resources Committee, 1990).
13. Ibid.
14. See, for example, *The 1987 Constitutional Accord: The Report of the Special Joint Committee of the Senate and the House of Commons*, in which suggestions were made for elements required for effective consideration of the constitutional future of the two territories after ratification of the Meech Lake Accord.
15. *Science and the North: A Seminar on Guidelines for Scientific Activities in Northern Canada*, 15-18 October 1972 (Ottawa: The Sub-Committee on Science and Technology, Advisory Committee on Northern Development, 1973).
16. Department of Indian Affairs and Northern Development, *Guidelines for Scientific Activities in Canada's North* (Ottawa, 1978).
17. Science Council of Canada, *Northward Looking: A Strategy and a Science Policy for Northern Development*, report no. 26 (Ottawa: Minister of Supply and Services Canada, 1977).
18. E.F. Roots et al., *Canada and Polar Science* (Ottawa: Department of Indian and Northern Affairs, 1987), 87.
19. *The North and Canada's International Relations*, report of a working group of the National Capital Branch of the Canadian Institute of International Affairs (Ottawa: Canadian Arctic Resources Committee, 1988).
20. *Post-Secondary Education and the Canadian North*, brief by the Association of Canadian Universities for Northern Studies to the Standing Committee of the Secretary of State, House of Commons, February 1988.
21. During 1989 the Science Council, with the Canadian Chamber of Commerce and Canadian Advanced Technology Association, initiated 10 locally organized workshops to encourage the exchange of ideas about technology and local development. Findings from the workshops are contained in *Grassroots Initiatives, Global Success*, a report published in 1990 by the Science Council, the Canadian Advanced Technology Association, and the Canadian Chamber of Commerce.

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